

SD11
.R3

DISEASE DETECTION SURVEY
Air Pollution

Cuba Ranger District
Santa Fe National Forest
New Mexico

Jicarilla Ranger District
Carson National Forest
New Mexico

By
Robert C. Loomis
Forest Service, USDA
Division of Timber Management
517 Gold Avenue, SW
Albuquerque, New Mexico 87101

In August 1971, Robert Loomis, plant pathologist in the Forest Service Insect and Disease Branch, examined forest trees and associated plants on selected areas of the Cuba Ranger District, Santa Fe National Forest, New Mexico, and the Jicarilla Ranger District, Carson National Forest, New Mexico. The purpose of the survey was to determine if acute injury had occurred to forest trees and associated plants from SO₂ emitted by the Four Corners Power Generating Station near Farmington, New Mexico. No plant symptoms were found in any of the examined areas which could be attributed to SO₂ injury.

Method.--On the Cuba Ranger District, a detection system, consisting of six vegetative observation areas and four sulfation plate stations, was initiated in August 1970 (Fig. 1). On the Jicarilla Ranger District, a detection system, consisting of two vegetative observation areas and one sulfation plate station, was initiated in September 1970 (Fig. 2). Where possible, sulfation plate stations and observation areas were established together in species type and location most susceptible to SO₂ injury. By locating the sulfation plates and vegetative observation areas together, we may be able to determine if there is a relationship between sulfation rate and the presence or absence of plant injury. By finding areas most susceptible to SO₂ injury, the detection system is made more sensitive to possible SO₂ injury.

Property of
National FS Library
USDA Forest Service
240 W Prospect Rd
Fort Collins CO 80526

Fig. 1 --- Location of sulfation plates and vegetative observation areas.

● - Sulfation plate and observation area together.

○ - Observation area only.

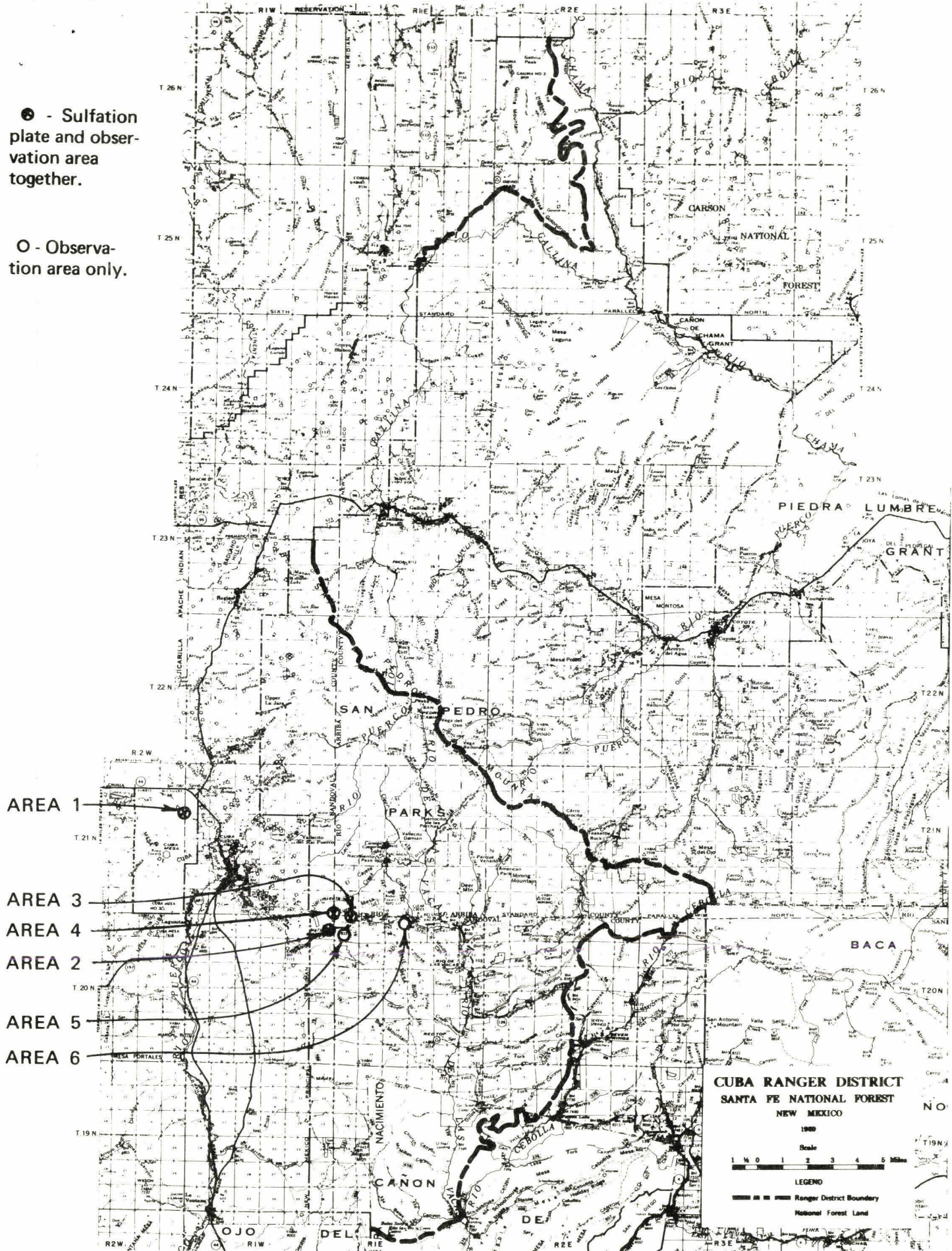
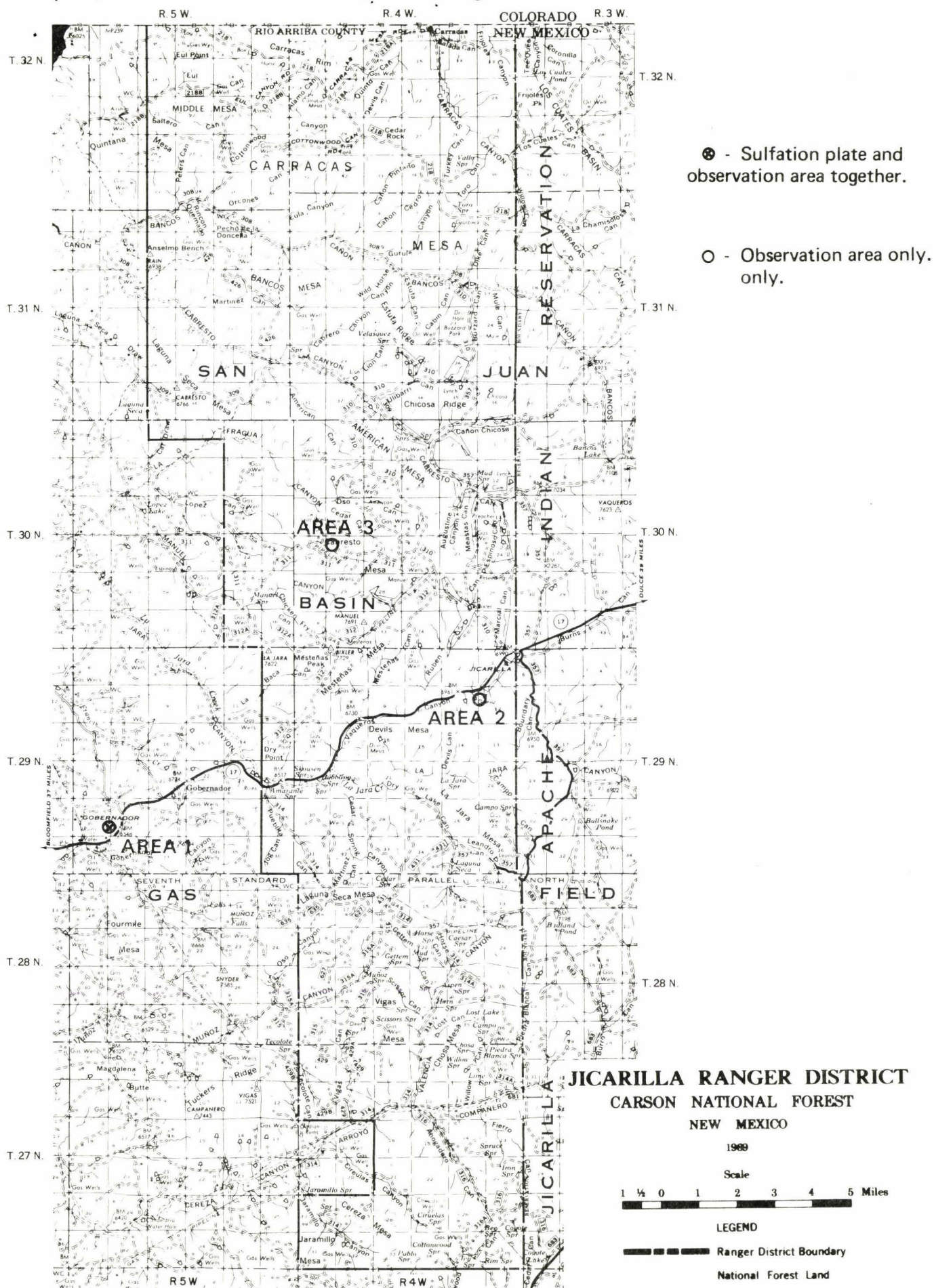


Fig. 2 --- Location of sulfation plates and vegetative observation areas.



Considerations for establishing observation areas include:

1. Presence of a variety of trees and associated plants growing in the area. One phase in evaluating possible SO₂ injury to plants is to determine if similar injury had occurred to a variety of plant species.
2. The observation areas should have adequate soil moisture. Plants growing in areas with adequate soil moisture and high humidity are more susceptible to SO₂ damage than plants growing under arid conditions.

The foliage of trees and associated plants was examined for the interveinal bleaching, interveinal necrosis, and tip burn typical of acute SO₂ injury. In addition, leaf and needle abnormalities from other causes were noted for future reference.

Results (Cuba Ranger District).--The following plant species were examined for evidence of acute SO₂ injury:

Forest Trees

Ponderosa pine (Pinus ponderosa)
Douglas-fir (Pseudotsuga menziesii)
Pinyon pine (Pinus edulis)
Juniper (Juniperus spp.)
Gambel oak (Quercus gambelii)
White fir (Abies concolor)
New Mexican locust (Robinia neomexicana)
Aspen (Populus tremuloides)
Narrowleaf cottonwood (Populus angustifolia)
Rocky Mountain maple (Acer glabrum)

Forest Plants and Shrubs

Mountain mahogany (Cercocarpus spp.)
Raspberry (Rubus spp.)
Snowberry (Symphoricarpos spp.)
Wild rose (Rosa spp.)
Hawthorn (Crataegus spp.)
Wild currant (Ribes spp.)

No symptoms of acute SO₂ injury were found on trees and plants in any of the observation areas. Tree and plant condition was noted as follows:

1. Ponderosa pine trees appeared healthy and vigorous. Needle retention was 3-4 years. A needle mottle or fleck of unknown cause

was noted on the older needles, but was not evident on the current year's needles.

2. Douglas-fir trees were heavily infected with dwarf mistletoe (*Arceuthobium douglasii*) on and near observation area 6. A gas line right-of-way and pumping station are in the vicinity of this area.

Sulfation plate data for the period August 1970-October 1971 are as follows:

Area 1 - Cuba Ranger District

<u>Month</u>	<u>Days exposed</u>	<u>* Sulfation rate (Micrograms SO₃/cm²/day)</u>
Aug. 1970	31	1.9
Sep.	31	** < Detectable minimum
Oct.	31	< Detectable minimum
Nov.	32	< Detectable minimum
Dec.	44	< Detectable minimum
Jan. 1971	26	4.9
Feb.	28	< Detectable minimum
Mar.	32	2.7
Apr.	28	3.7
May	32	< Detectable minimum
Jun.	30	< Detectable minimum
Jul.	32	1.4
Aug.	29	< Detectable minimum
Sep.	34	< Detectable minimum
Oct.	28	< Detectable minimum

Area 2 - Cuba Ranger District

Aug. 1970	31	2.2
Sep.	31	< Detectable minimum
Oct.	31	< Detectable minimum
Nov.	32	2.5
Dec.	44	1.7
Jan. 1971	26	2.2
Feb.	28	< Detectable minimum
Mar.	32	2.7
Apr.	28	1.9
May	32	1.8
Jun.	30	< Detectable minimum
Jul.	32	< Detectable minimum
Aug.	29	1.6
Sep.	34	< Detectable minimum
Oct.	28	< Detectable minimum

* Corning Laboratories, Inc., Cedar Falls, Iowa, supplies and analyzes all sulfation plates.

** Detectable minimum for 30-day period (micrograms SO₃/cm²/day)
 Sep. 1970-Mar. 1971 - 1.2; Apr. 1971-Sep. 1971 - 1.0;
 Oct. 1971 - 0.8

Area 3 - Cuba Ranger District

<u>Month</u>	<u>Days exposed</u>	<u>* Sulfation rate (Micrograms SO₃/cm²/day)</u>
Aug. 1970	31	** < Detectable minimum
Sep.	31	< Detectable minimum
Oct.	31	< Detectable minimum
Nov.	32	< Detectable minimum
Dec.	44	< Detectable minimum
Jan. 1971	26	2.2
Feb.	28	3.3
Mar.	32	1.6
Apr.	28	3.1
May	32	< Detectable minimum
Jun.	30	< Detectable minimum
Jul.	32	< Detectable minimum
Aug.	29	< Detectable minimum
Sep.	34	< Detectable minimum
Oct.	28	< Detectable minimum

Area 4 - Cuba Ranger District

Aug. 1970	30	2.1
Sep.	31	< Detectable minimum
Oct.	31	< Detectable minimum
Nov.	32	< Detectable minimum
Dec-Jan. 1971	69	< Detectable minimum
Feb.	28	< Detectable minimum
Mar.	32	2.7
Apr.	28	3.1
May	32	< Detectable minimum
Jun.	30	< Detectable minimum
Jul.	32	3.4
Aug.	30	< Detectable minimum
Sep.	33	< Detectable minimum
Oct.	28	< Detectable minimum

* Corning Laboratories, Inc., Cedar Falls, Iowa, supplies and analyzes all sulfation plates.

** Detectable minimum for 30-day period (micrograms SO₃/cm²/day)
 Sep. 1970-Mar. 1971 - 1.2
 Apr. 1971-Sep. 1971 - 1.0
 Oct. 1971 - 0.8

Results (Jicarilla Ranger District).--The following plant species were examined for evidence of SO₂ injury:

Forest Trees

Ponderosa pine (Pinus ponderosa)
Aspen (Populus tremuloides)
Pinyon pine (Pinus edulis)
Juniper (Juniperus spp.)
Gambel oak (Quercus gambelii)
Wild cherry (Prunus spp.)

Forest Plants and Shrubs

Mountain mahogany (Cercocarpus spp.)
Wild rose (Rosa spp.)
Snowberry (Symphoricarpos spp.)
Rabbit brush (Chrysothamnus spp.)
Sagebrush (Artemisia spp.)
Cocklebur (Xanthium spp.)

No symptoms of acute SO₂ injury were found on trees and plants in any of the observation areas. Tree and plant condition was noted as follows:

1. Ponderosa pine trees appeared healthy and vigorous. Needle retention was 3-4 years. A needle mottle or fleck of unknown cause was noted on the older needles in area 3. A few spots or flecks had begun to show on the current year's needles.

2. Aspen trees in area 3 appeared to be declining. There were no leaf markings or other leaf abnormalities noted.

Sulfation plate data for the period September 1970-October 1971 are as follows:

Area 1 - Jicarilla Ranger District

<u>Month</u>	<u>Days exposed</u>	* Sulfation rate (Micrograms SO ₃ /cm ² /day)
Sep. 1970	18	** <Detectable minimum
Oct.	46	<Detectable minimum
Nov.	18	<Detectable minimum
Dec.	27	<Detectable minimum
Jan. 1971	37	<Detectable minimum

Area 1 - Jicarilla Ranger District (cont'd)

<u>Month</u>	<u>Days exposed</u>	<u>* Sulfation rate (Micrograms SO₃/cm²/day)</u>
Feb. 1971	20	2.9
Mar.	34	3.1
Apr.	32	1.6
May	33	1.2
Jun.	26	** < Detectable minimum
Jul.	29	3.8
Aug.	31	< Detectable minimum
Sep.	31	< Detectable minimum
Oct.	36	1.1

* Corning Laboratories, Inc., Cedar Falls, Iowa, supplies and analyzes all sulfation plates.

** Detectable minimum for 30-day period (micrograms SO₃/cm²/day)
Sep. 1970-Mar. 1971 - 1.2
Apr. 1971-Sep. 1971 - 1.0
Oct. 1971 - 0.8

Discussion.--Diagnosis of air pollution injury to vegetation is complicated by environmental, insect, and other disease factors. These factors can cause leaf and plant symptoms which appear similar to air pollution injury. In addition, the occurrence or severity of air pollution-caused plant injury is determined not only by the pollutant concentrations and duration of exposure, but by many environmental factors which can affect individual plant sensitivity. These factors include light, moisture, temperature, and nutrient relations.^{1/}

To date, the only places we have found acute SO₂ injury to Southwestern forest vegetation have been within 4 miles of the source emitting SO₂. Therefore, the lack of acute damage symptoms might be expected because the Jicarilla Ranger District and the Cuba Ranger District are more than 60 miles and 90 miles, respectively, from the Four Corners Power Station. A study prepared by the U.S. Department of Health, Education, and Welfare, Bureau of Abatement and Control,^{2/} suggests that plant

^{1/} Treshow, M. 1970. Environment and Plant Response. McGraw-Hill Book Co., N.Y. 422 p.

^{2/} Estimates of Air Pollution Concentrations from Four Corners Power Plant, New Mexico. 1970. Division of Control Agency Development, Bureau of Abatement and Control, U.S. Dept. Health, Education, and Welfare.

damage is most likely to occur within a radius of 10 miles of the Four Corners Power Station, but that there is a possibility of detectable damage to sensitive vegetation located on the western edges of the Carson and Santa Fe National Forests. This document also suggests that during initial surveys, such as the one reported here, little or no damage may be discovered, but that the information obtained will be useful when evaluating the impact of additional power plant units in the Four Corners area.

Sulfation plates are being used to determine if SO_2 and other sulfur compounds are reaching the vegetative observation areas.^{3/} The sulfation plates are exposed for approximately 30 days, during which time sulfur compounds react with the lead dioxide in the plate. The product of these reactants is then measured and expressed as micrograms $\text{SO}_3/\text{cm}^2/\text{day}$.^{4/} This is commonly called the sulfation rate. Sulfation plate data show that most average sulfation rates are at or near rates which might be expected in areas remote from an SO_2 source. Levels of SO_2 and other sulfur compounds which produced measurable sulfation rates were not sufficiently high to cause acute plant injury in the observation areas. These plates provide an economical way of determining the general dispersion of total sulfur compounds, and, therefore, may prove useful in finding locations more susceptible to SO_2 injury. Eventually, it may be possible to develop an area plant hazard rating system based on average sulfation rates and relative susceptibility of native forest species.

In order to get some idea of sulfation plate reliability, duplicate plates were exposed in five locations in New Mexico and Arizona. The sulfation rates of several individual plate-pairs varied considerably; however, when all plate-pairs are considered, there is a highly significant correlation between the sulfation rates on each of the plate-pairs ($R = 0.697$ with 18 degrees of freedom). There is no significant difference between the average of the means of each set of plate-pairs ($T = 0.233$ with 18 degrees of freedom).

Attached is a map of Arizona and New Mexico showing the complete air pollution plant injury detection network established by the Forest Service Insect and Disease Branch.

^{3/} Tucson Advisory Committee on Air Pollution. 1971. Air Pollution in Tucson: A Report to the Mayor and Council of the City of Tucson. Edited by R. Caldwell. 141 p.

^{4/} Huey, N. A. 1968. The Lead Dioxide Estimation of Sulfur Dioxide Pollution. J. Air Poll. Control Assoc. 18: 9.

Recommendations.--

1. Conduct detection surveys on both the Cuba Ranger District and the Jicarilla Ranger District in late summer of 1972 to determine if any symptoms of acute or chronic SO₂ injury can be noted.
2. Re-establish the sulfation plate network when the San Juan Electrical Generating Station, located at Waterflow, New Mexico, begins operation in July 1973.

AIR POLLUTION DETECTION SURVEY - 1971 U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

REGION 3

